RELATION OF THE WEATHER TO THE YIELD OF WHEAT IN MANITOBA.

By A. J. CONNOR.

Dominion Meteorological Office, Toronto.

[Extracts.]

(Monthly Bulletin of Agricultural Statistics, Dominion of Canada, April, 1918, pp. 115-125.)

* * * "The plots [at the various experiment stations] are always as near to the meteorological instruments as is found feasible. Dates of sowing, appearance above ground, stooling, stem roots, heading, flowering, milk-stage, maturity, cutting, are carefully noted, as well as the average height of the plants every seven days.

* * * "Some of the preliminary findings were as follows:

"(1) There appeared to be a relation between the length of the period from sowing to heading, or from the appearance of the plants to heading, and the subsequent yield, the longer periods being positively related to the greater yields.

* * * "It therefore appears that the true explanation of the 'critical period' is as follows. If in the earlier stages of the wheat's growth there be cool and rainy weather, the heading will be delayed and the subsequent yield will be heavy, but if the weather be warm and dry, heading will be hastened and the subsequent yield will be light.

* * * "In regard to rainfall there appears that (1) the effect of the rainfall of the 30 days preceding sowing had, in the long run, no effect upon the subsequent yield; (2) in each of the 30 day periods after sowing, and in all combinations of them, the effect of increased rainfall was to increase the yield, except, perhaps, the fourth; (3) the rainfall of the third 30 days after sowing was the most potent in increasing the yield; (4) that the rainfall effect was cumulative, the correlation coefficient for the 120 days being the largest.

"In regard to mean daily range of temperature there appears (1) that in all the 30-day periods succeeding sowing the coefficient was negative, indicating that the yield was increased by a lowered range; (2) that in the case of the first period after sowing the coefficient is negligible; (3) that in the case of the third period the coefficient is largest, five and one-half times the probable error; (4) that any combination of other periods with the third produces a smaller coefficient than that for the third alone.

"In regard to mean daily minimum temperature, we have that (1) the effect of this factor in the first and fourth periods after sowing is zero; (2) in the second and third periods the coefficient is negative, indicating that the yield is increased by a lowered temperature; (3) in the case of the third 30 days after sowing, the coefficient is greatest; (4) combinations of other periods with the third produce a smaller coefficient.

* * * "From the results so far attained it is not educible that there is a critical period of short duration. The coefficients for the third 30 days after sowing are the largest, but this division into 30-day periods was arbitrarily chosen, and there is nothing to show that a larger or smaller period, if chosen, might not have revealed still larger coefficients. From the two sets of data, together, without more detailed treatment, we may assert, with fair justification, that the first 90 days after sowing are very important with regard to moisture and coolness, but that ordinarily there is sufficient moisture in the soil in the first 60 days for the young plants, and low enough ranges of temperature to prevent evaporation to a harmful extent. During the latter part of the 90-day period, however, there will ordinarily obtain midsummer weather with increased probability of heat and drought, and in this regard the last part of the 90 days after sowing may be said to be a "critical period." If in this "critical" time the weather be warm, dry, with great temperature range, the wheat plants will head early and the harvest will be light, but if the cool and moist conditions continue, heading will be postponed and the yield increased. Now, the average date of sowing of wheat in Manitoba since 1890 is approximately April 25, which will fix the average time of the "critical period" as the last week of June and the first three weeks of July. Hence the variability of early July weather may be regarded as the "critical factor" in wheat production in Manitoba.

* * * "The three variables used were the rainfall, mean daily minimum temperature, and mean daily range of temperature, all for the third 30 days after sowing, and it was found that these are to some extent intercorrelated. The minimum is slightly and the rainfall to a much greater degree correlated with the range, both negatively, while there is no relation between the minimum and the rain. Since the rainfall is related positively and the other factors negatively to the yield of wheat, the quotient $\frac{\text{Rain}}{\text{Range} \times \text{minimum}}$ should be related positively. The plotting of these quotients against the yields led to the following equation:

If Y be the yield in bushels per acre,
m the mean minimum temperature,
p the total precipitation for 30 days,
r the mean daily range,
m^1 be $(m-40)$,

then—

$$Y = .434\left(m-\frac{r}{2}\right)\log\frac{1000p}{rm^1}$$

If the mean daily temperature be denoted by t, then the quantity $\left(m-\frac{r}{2}\right)$ may be written $(t-r)$.[1]

PREDICTING MINIMUM TEMPERATURES.[2]

By J. WARREN SMITH, Meteorologist.

[Weather Bureau, Washington, D. C.]

[Author's abstract.]

A mathematical discussion of the relation between the relative humidity in the late afternoon and the variation of the minimum temperature during the coming night from the afternoon dewpoint temperature, when radiation conditions prevail.

The study shows that there is a well-defined relation which can be expressed by the curve for a parabola. This curve can be constructed by the "star point" method of curve fitting instead of by the more tedious well-known least square method.

[1] It is probable that closer approximation might be obtained by least-square treatment of $(m-40)$, the constant 40 being slightly changed.

[2] Presented before the Philosophical Society of Washington Dec. 20, 1919, and the American Meteorological Society, St. Louis, Dec. 30, 1919. To be published in full in MONTHLY WEATHER REVIEW SUPPLEMENT 16, 1920.

The equation used is written $v=x+by+cz$. In which v is the variation of the minimum temperature from the evening dewpoint; b is the evening relative humidity, and c is the square of the relative humidity; x, y, and z are the three unknowns, which are evaluated from three normal equations which are readily written by the star point method, after the data have been properly charted.

The results are remarkably accurate. The studies show that the minimum temperature can be closely predicted in the orchard at considerable distance from the observing station; that the hygrometric observations made at noon may be used quite as well in some instances as those made in the evening, and that the equation will sometimes apply as well to cloudy as to clear nights.

DISCUSSION.

Prof. H. J. Cox remarked that the cranberry marshes of Wisconsin showed extraordinarily low temperatures, considering the high humidities, which condition he ascribed to the shallowness of the moist blanket of air.

Prof. W. J. Humphreys told of a case where, in order to protect his orchard, a farmer had driven his cattle and horses back and forth through the orchard, and the animal heat was sufficient to protect the trees against frost. This has the double advantage of supplying heat at moderate temperature in such a manner that it will not rise quickly above the trees, and of stirring the air.

FORECASTING FROSTS.

By B. A. KEEN.

[Discussed by J. Warren Smith.

(Nature, Jan. 1, 1920, p. 450.)

The author refers to different methods of frost protection and minimum temperature forecasting. Under frosts the writer says:

Up to the present, no complete correlation has been made of frost in any particular locality and its causes. For this purpose an examination by statistical methods of a series of continuous observations (of the automatic recording type) of meteorological factors is needed. The published papers deal usually with one factor, such as dewpoint or air temperature, and the number of daily observations made is small. This is due, no doubt, to the necessity of keeping the cost of apparatus and working as low as possible for the sake of the growers. However, a general idea of the factors concerned can be obtained from a broad survey of the various papers.

For several seasons the Weather Bureau has been making a careful temperature and frost survey in the citrus district at Pomona, Calif., and the deciduous fruit orchards near Medford, Oreg. Very valuable data have been collected on temperature differences as affected by topography, temperature fluctuations as affected by wind movement, changes in the dewpoint during the night, radiation with and without a smoke or smudge cover, and the temperature at different elevations when orchard heating is going on. A large number of thermometers have been exposed and special long-range thermographs kept in use. The radiation observations have been made with special apparatus used by the Solar Radiation Division of the Bureau. The work is now under the direction of Mr. Floyd D. Young, and the results will soon appear in print (in Farmers' Bulletin 1096).

One important result has been to show that so-called smudges are of small value as compared with the dry-heat method of orchard heating.

In connection with the forecasting problem Mr. Keen refers to a study by Hellman on the effect of an overcast sky on air temperatures near the ground. (Preuss. Akad. Wiss., Berlin, 38, 1918, p. 806); on various methods of predicting the minimum temperatures on radiation nights by Smith (U. S. MONTHLY WEATHER REVIEW 42, 1914, 573; 4, 1917, p. 402) and some observations by Franklin on the cooling of the soil at night, with special reference to late spring frosts. (Proc. Royal. Soc., Edin., 39, 1919, p. 120.)

The credit given J. Warren Smith in originating the median-hour method of predicting minimum temperatures should be only in the application of the idea which was first noticed by the writer in an article by E. A. Beals.

Referring to the study by T. B. Franklin, the writer says:

"As a result of observations of temperatures in the air, on the soil, and at a depth of 4 inches, Franklin concludes that a prediction of frost depends on assessing the value of: (1) Average relative humidity during the night; (2) the temperature of a given depth (4 inches) at the time of surface minimum temperature; (3) the conductivity of the layer between the assigned depth and the surface; and (4) the difference between the surface-soil minimum and that of the air above it. These determinations are necessary because: (1) The radiation from the soil on calm, clear nights is a function of the relative humidity (A. Ångström, Smithsonian Misc. Coll., 65 No. 3); (2) the radiation from the soil can be accounted for in balancing the upward conduction and the latent heat of freezing, the residue only cooling the soil; and (3) the temperature of the surface soil rapidly falls sufficiently below the temperature of the 4-inch depth to make the conduction from this depth balance the radiation; after this the surface temperature falls no faster than that of the 4-inch depth."

WINTER INJURY OF FRUIT TREES.

By JOSEPH ASKAMP.

(Abstracted from Circ. 87, 12 p., illus., Purdue Univ. Agr. Expt. Sta., 1918.)

The severe winter of 1917–18 has caused irreparable damage to thousands of peach and apple orchards in Indiana.[1] The heaviest toll was taken of the peaches, amounting all the way from very slight or no injury to the complete destruction of entire orchard tracts. It seems safe to say that for the State as a whole the damage has cut the bearing acreage of peaches at least 60 per cent. The mortality among young peach trees which had not yet borne fruit was small, however, so that in a short time normal production should be restored.

"A part of the acreage where the injury was severe will probably not be planted again to peaches. This is as it should be, for many of these locations were not well adapted to such a tender fruit. While the trees in many such locations were heretofore able to survive the winters, the buds or blossoms were more commonly killed than in more favorable situations. * * *

* * * "In the case of the apple, the young trees from 3 to 14 years old suffered the greatest injury. * * *

[1] During December and January unusually severe weather prevailed over the greater part of the country east of the Rocky Mountains, especially in the length of time that low temperatures were maintained and the large area involved. The cold weather continued into the first part of February in the northeast.

In Illinois the temperature fell to −23° F. in December and January and to −24° in February. A record of −30° was reached in Indiana in December, −24° in January, and −22° in February. In Ohio the lowest reported was −31° in December and −24° in January and February. The temperature fell to from 40° to 42° below zero F. at a number of places in the plateau districts of New York on December 30, and to below −30° during both January and February. (See MONTHLY WEATHER REVIEW, Dec., 1918, 46: 570–580.)—*J. W. S*